早期科学项目 3052

名称：GAIA DR2 中的脉冲星搜寻与研究 (Searching and studying binary pulsars from GAIA DR2 sources)

科学意义：The GAIA space observatory mission has delivered astrometric measurements for an unprecedented number of objects in the Galaxy. Among the 1.5 billion sources that have been measured proper motion for, approximately 30,000 are low-mass white dwarfs (LMWDs, less than 0.25 solar mass). Because these objects can only be formed in binary systems, those without apparent optically companion are very likely to be in orbit with another compact object, such as a neutron star. Therefore, this type of GAIA sources are potentially excellent targets for finding new binary neutron stars. Overall, it has been estimated that 1-3% of the GAIA LMWDs are expected to have recycled millisecond pulsar companions (Nelemans et al. 2001; van Leeuwen et al. 2007).

Binary millisecond pulsars have been demonstrated to be excellent astrophysical laboratories in testing gravity with high precision (Kramer et al. 2006) and probing the behaviour of matter at ultra-high energy density (Antoniadis et al. 2013), both of which are considered as pathfinders to reconciling General Relativity and quantum theory. Finding new binary pulsar systems has the potential to enable novel experiments by e.g., increasing the maximum measured mass of neutron stars, which would place even tighter constraint on neutron star equation-of-state and improve our understanding of nuclear physics at ultra-high density.

FAST的独特优势：The high sensitivity of FAST (~ twice as Arecibo at L-band) will enable the deepest target search towards the GAIA DR2 sources. This will also downgrade the complexity in data reduction in finding binary pulsars. A deep search even without any new discoveries will provide a stringent upper limit on the flux density of the companion and can be used to constrain binary evolution and population synthesis models.

接收机及基本技术要求：We will use the multi-beam receiver to observe at L-band. Only data from the central beam needs to be recorded. We also require recording the baseband data at the same time to later improve the quality of the detection and perform more sophisticated searches.

源表：A preliminary version is provided below (contact with 刘阔):

Sources	RA	Dec

J2032+3937	308.28	+39.62
J2037+4322	309.16	+43.49
J1949+2513	297.74	+25.36
J2035+4121	309.27	+41.59
J2027+4003	306.74	+39.90
J2022+3840	305.62	+38.84

观测时间：30 min/source

数据存储需求：3.6 Gb/s, 40 TB in total

预期成果：A number of binary millisecond pulsars are likely to be discovered from the target search. Follow-up timing and optical observations can yield the property measurements of the systems including the neutron star mass. These results shall be used to perform test of gravity, constrain neutron star equation-of-state and study the evolution path of the systems.

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参考文献：

Antoniadis et al., 2013, Science, 340, 448
Kramer, M. et al., 2006, Science, 314, 97
Nelemans, G. et al., 2001, Astronomy and Astrophysics, 375, 890
van Leeuwen et al., 2007, MNRAS, 374, 1437